

PRELIMINARY OBSERVATIONS ON THE ROLE OF COFFEE PLANTATIONS AS AVIFAUNAL REFUGES IN THE PALNI HILLS OF THE WESTERN GHATS¹

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(With two text figures)

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A preliminary study was undertaken to explore the role of coffee plantations as a refuge for the avifauna of fragmented forest patches in the middle Palnis of the Western Ghats. This was done by systematic observations using the line transect method in 6 one-hectare plantation plots and 3 forest plots in 2 valleys. Species composition, species richness and feeding guild abundances were compared between the two habitat types using non-parametric tests. Species composition of avifauna was found to be significantly different between forest and plantation plots. Several native forest-loving species were not observed foraging in plantations. The insectivorous guild was found to be more often sighted in forest habitat, while the omnivorous guild was found to be more abundant in the plantation habitat. However, the plantation habitat appeared to be a valuable secondary habitat for the foraging of a large subset of forest-dwelling species and may possibly be an effective buffer between fragmented forest habitat patches in this area. These are very preliminary trends for the season of study and need to be followed up with long-term detailed studies, both to confirm the trends observed in this study and to find out the modifications in agricultural practices, if any, needed to maximise the avifaunal conservation potential of coffee plantations in the middle Palnis.

INTRODUCTION

The Palni Hills are the southeastern offshoot of the Western Ghats in Tamil Nadu, ranging in altitude from 300 m to nearly 2500 m above msl. They cover an area of approximately 2400 sq. km and encompass a wide diversity of natural habitats ranging from evergreen montane forests (sholas) and grasslands in the higher reaches to scrub forest in the foothills (Sustainable Development Program, 1992).

The zone of the Palni Hills from 1000 to 1500 m is popularly known as the middle Palnis, and has the natural vegetation cover of moist deciduous and semi-evergreen forest which supports a rich diversity of avifauna, among other taxa. Expanding agricultural activity currently threatens to take over the natural habitat in this zone.

Coffee-planting and its effect on bird communities

Coffee-planting (*Coffea robusta*; *Coffea arabica*) was observed to be a dominant agricultural activity in the area. Coffee plantations had already taken over vast tracts of forest land, fragmenting it into 'islands' of original habitat. These 'islands' lay scattered in a mosaic of coffee plantations and other agricultural land use, some cultivated areas extending up to 400 acres.

The change from a multi-species, multilayered forest ecosystem to a monoculture of coffee bushes with a species-poor canopy is likely to have several negative effects on bird communities. This is due to a combination of microhabitat changes which take place during the process of conversion. Some of them are as follows:

1. Removal of the forest understorey and its replacement with a single shrub species, i.e. coffee.
2. Replacement of the existing forest trees with a few selected indigenous and exotic tree species,

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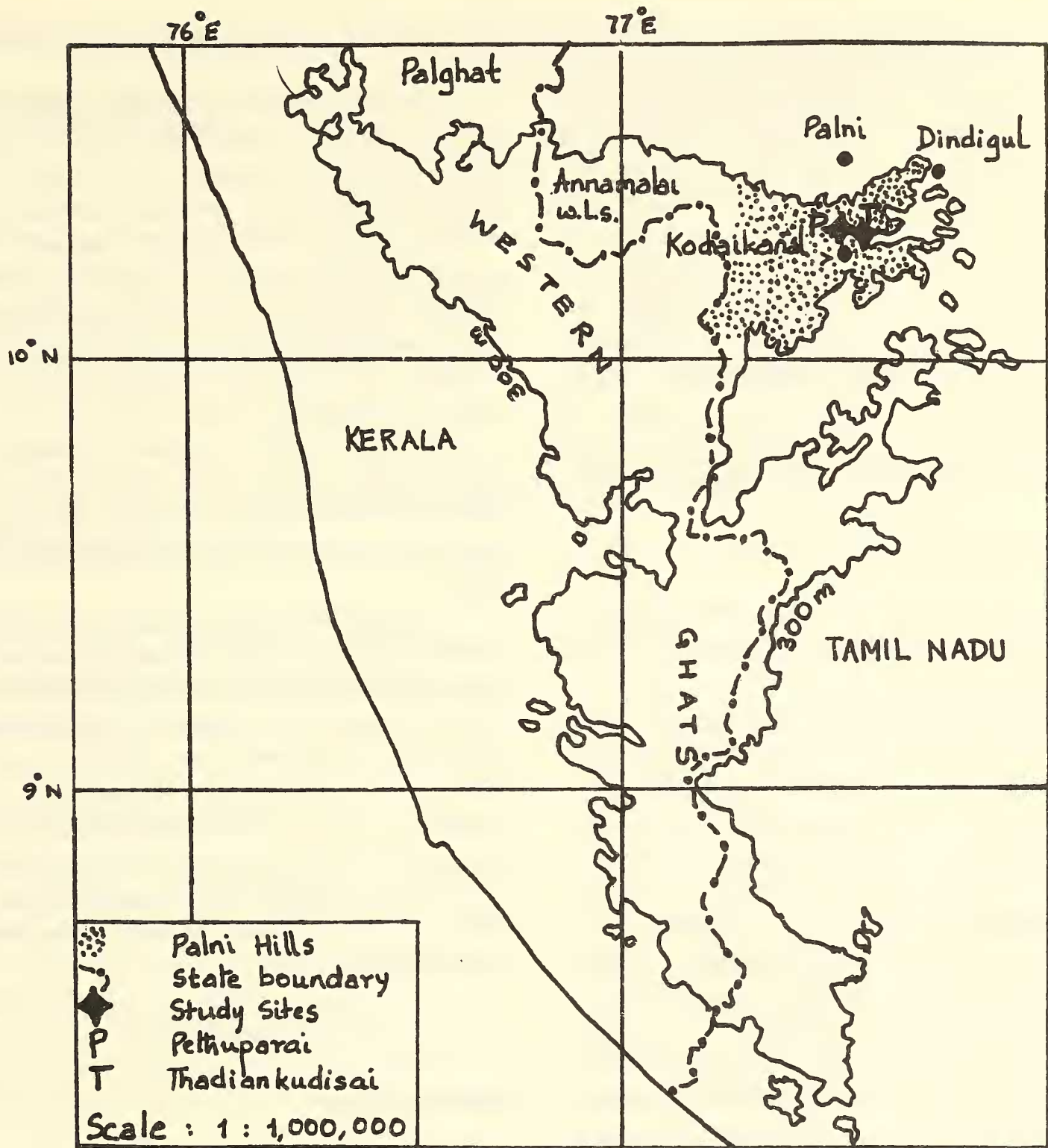


Fig. 1: The Palni Hills in relation to rest of the Western Ghats (Southern portion) and the location of study sites within them.

- which are widely spaced and regularly pruned.
- 3. Use of pesticides for control of insect, virus and nematode pests.
- 4. Overall reduction in quantity of leaf litter.

OBJECTIVES

In this study I aimed to investigate the role of coffee plantations in the conservation of avifaunal

species occurring in the natural forest habitat of the Middle Palni Hills. The study specifically aimed at exploring the impact of coffee-planting as an agricultural activity, on species richness, species composition and guild abundance of the avifaunal community of this area. I also intended to document the birdlife of this highly diverse, but neglected area of the Palni Hills.

I expected that the findings would help to indicate the avifaunal conservation potential of coffee plantations in the middle Palnis. I also designed it as a starting point for detailed studies aimed at designing/modifying agricultural practices so as to retain a high proportion of the original species pool of the natural habitat of the area, even while it is being used for economic activity. In the face of continual fragmentation of natural ecosystems, the challenge to conservation today is to reduce the structural contrast between habitat fragments and the matrix in which they exist, in order to preserve as much of the native species pool as possible (Wilcove, McLellan & Dobson, 1986; Meffe & Carroll, 1994).

STUDY SITES AND METHODOLOGY

The study was undertaken in two valleys of the Palni Hills - Pethuparai and Thadiankudisai during May and June, 1991.

Pethuparai valley is located in the northwestern section of the Palnis (Fig. 1). This area has recently come under coffee cultivation. The river Tayankariar runs through the centre of the valley on both sides of which lie a mosaic of coffee plantations, rice fields and other cultivation. There is almost no original forest habitat left in the area. The remnants consist of one or two small, degraded stands of *Syzygium cumini*, *Grewia tilifolia*, *Mangifera indica*, *Gmelina arborea* and *Terminalia bellerica*, among other species. A typical plantation in the area had shade trees of silver oak (*Grevillea robusta*), coral tree (*Erythrina lithosperma*) and jackfruit (*Artocarpus heterophyllus*); and an understorey of orange and pomegranate trees interspersed among coffee bushes.

Thadiankudisai valley, in the eastern section of the Palnis (Fig. 1), is drained by the Kodavananar river and is a prime coffee-growing area. Large patches of moist deciduous and semi-evergreen forest habitat still exist in this valley, having tree species such as *Trema orientalis*, *Messua ferrea*, *Acrocarpus fraxinifolius*, *Elaeocarpus serratus* and *Melia dubia*. Coffee plantations are very similar to those at Pethuparai except that here pepper (*Piper*

betel) is grown commonly as a climber on the silver oak trees.

Three plantations in Pethuparai valley (P1, P2 and P3), three in Thadiankudisai (P4, P5 and P6) and three forest patches (F1, F2 and F3) in Thadiankudisai were chosen for the study. In each of these areas, a 1-hectare plot was marked out which was relatively homogenous in terms of vegetation. For six hours, the plot was intensively explored by a regular path that covered the whole plot. The hours of observation for each plot ranged from 6 am to 9 am and from 2 pm to 5 pm.

Whenever a bird was sighted, it was identified and notes were made on the approximate height above the ground where it was seen, the vegetation layer it was seen in and its foraging/breeding activity, if any.

The number of tree species in each plot were enumerated. The canopy cover and depth of leaf litter were ranked as low (L) or high (H), based on visual observations. In the case of plantation plots, information was gathered on pesticide use, coffee yield and major crop pests by talking to the owners/managers of the respective plantations. The surrounding land use for each plot was ascertained by extensive trekking in the respective area. The details that were obtained on these aspects for each plot are given in Table 1.

RESULTS AND DISCUSSION

Species Richness

A total of 58 bird species was recorded from the six plots in Thadiankudisai area during the period of observation. In addition, 11 species were recorded outside the count hours and/or study plots. In terms of species richness, there was no difference between the forest and plantation habitats according to a two-tailed non-parametric Wilcoxon rank sum test ($U=0.3899$; $p>0.6966$). Table 2 gives the list of bird species found in Thadiankudisai and the habitats they were seen in.

In Pethuparai valley 45 species were seen during birdcounts while 19 were recorded outside

TABLE I
DETAILS OF THE STUDY PLOTS IN PETHUPARAI AND THADIANKUDISAI VALLEYS

Plot No.	Name of Estate/Forest	Alt. (metres)	Tree sp. richness	Leaf Litter	Pesticide use	Surrounding Land use	Canopy cover	Bird sp. Richness
P1	Bhagyadan plantation	1100	14	H	Org.	Agri, River	L	24
P2	Brian Jenkins' Plantation	1100	33	H	Org.	Agri	H	27
P3	Avari Estate	1200	17	L	Non-org.	Agri	L	25
P4	Attakadu Estate	1000	13	L	Non-org.	Forest, River	L	32
P5	N.T.K. Estate	1000	18	L	Org.	Agri, River	H	27
P6	Coffee Demonstration Farm	1000	6	L	Non-org.	Agri, Forest	L	21
F1	Sengarakanal R.F.	1000	25	H	—	Agri, Forest	H	24
F2	Ponnaivetti R.F.	1100	28	H	—	River, Agri, Forest	H	28
F3	Ponnaivetti R.F.	1100	>30	H	—	River, Forest	H	27

Key: Alt.: Altitude; sp: species; L: Low; H: High; Org: Organic; Non-Org: Non-Organic; Agri; Agricultural; RF: Reserved Forest

the study plots/count hours. The bird species richness was comparable to that in Thadiankudisai plantations even though there was almost no colonising forest habitat left here besides some degraded forest patches.

Species Composition

In Thadiankudisai, 44 species were seen foraging in the forest plots while 47 were recorded in the coffee plantation plots. 33 species were recorded in both types of habitat and therefore there was nearly a 57% similarity of bird species composition between the two habitat types (according to Jaccard's Index).

$$\text{Jaccard's Index of Similarity} = \frac{\text{No. of species common to both habitats}}{\text{Cumulative no. of species in the two habitats}} = 56.9\%$$

(Refer to Table 2 for a listing of habitat-wise occurrence of all the bird species of the area).

Indices of similarity were also calculated between each pair of plots, whether forest or plantation. The results are shown in Table 4. Indices of similarity of species composition between similar habitat-plots, such as between F1 and F2 or between P1 and P3, for example, indicated the level of

similarity between pairs of plots belonging to the same habitat type. Similarly, indices of similarity between pairs of plots belonging to contrasting habitat types, such as between P1 and F1 or between P1 and F3, for example, indicated the level of similarity between pairs of plots belonging to contrasting habitat types.

I hypothesised that the degree of similarity between pairs of plots belonging to similar habitat types should be greater, on an average, than that between pairs of plots belonging to contrasting habitat types, if the two habitat types differed significantly in terms of species composition. Using a one-tailed Wilcoxon rank sum test, I found a significant difference ($U=2.0145, p < 0.02$). Thus I concluded that species composition of forest plots differs significantly from that of plantation plots.

Out of the 44 species found in the forest plots, 33 were seen in one or more plantation plots also (Table 2). This indicates that coffee plantations are capable of supporting the foraging of a high percentage of forest avifauna, i.e. 75%. This included species such as the grey junglefowl, Indian lorikeet, grackle myna, greater racquet-tailed drongo and the little spiderhunter. However, these species could have been seen foraging inside plantations only because the latter were located close to thick forest patches which are the primary habitat for these birds

TABLE 2
CHECKLIST OF THE BIRD SPECIES OF THADIANKUDISAI AREA, PALNI HILLS, WESTERN GHATS

Family & Synopsis No.	Name of species	Feeding Guild	Presence in: Forest	Plantation
Family Accipitridae				
139	Shikra	BOP		**
144	Crested Goshawk	BOP	**	
172	Black Eagle	BOP		**
196	Crested Serpent-Eagle	BOP	**	**
Family Phasianidae				
301	Grey Junglefowl	GRA	**	**
Family Rallidae				
343	Whitebreasted Waterhen	AQU		**
Family Columbidae				
537	Spotted Dove	GRA		**
542	Emerald Dove	GRA	**	
Family Psittacidae				
550	Roseringed Parakeet	FSE	**	
558	Blossomheaded Parakeet	FSE	**	**
564	Bluewinged Parakeet	FSE	**	**
566	Indian Lorikeet	FNE	**	**
Family Cuculidae				
573	Common Hawk-Cuckoo	INS	**	**
595	Small Green-billed Malkoha	INS	**	
600	Crow-Pheasant	INS	**	**
Family Apodidae				
709	Crested Tree Swift	INS		**
Family Trogonidae				
712	Malabar Trogon	INS	**	
Family Alcedinidae				
735	Whitebreasted Kingfisher	INS		**
Family Meropidae				
744	Chestnutheaded Bee-Eater	INS	**	**
Family Upupidae				
763	Hoopoe	INS		**
Family Bucerotidae				
768	Malabar Grey Hornbill	FRU	**	
775	Malabar Pied Hornbill	FRU	**	
Family Capitonidae				
785	Small Green Barbet	FRU	**	**
792	Crimson-Breasted Barbet	FRU	**	**
Family Picidae				
798	Speckled piculet	INS		**
808	Little Scaly-bellied Green Woodpecker	INS	**	**
819	Lesser Goldenbacked Woodpecker	INS	**	**
825	Indian Goldenbacked Threetoed Woodpecker	INS	**	**
861	Larger Goldenbacked Woodpecker	INS	**	
Family Hirundinidae				
923	Redrumped Swallow	INS		**

Table 2 (contd.)

CHECKLIST OF THE BIRD SPECIES OF THADIANKUDISAI AREA, PALNI HILLS, WESTERN GHATS

Family & Synopsis No.	Name of species	Feeding Guild	Presence in: Forest	Plantation
Family Dicruridae				
965	Ashy Drongo	INS	**	
971	Bronzed Drongo	INS	**	**
977	Greater Racquet-tailed Drongo	INS	**	**
Family Artamidae				
982	Ashy Swallow-Shrike	INS		**
Family Sturnidae				
1015	Grackle Mynah	FRU	**	**
1009	Jungle Mynah	OMN	**	**
Family Corvidae				
1032	Indian Treepie	OMN	**	**
1054	Jungle Crow	OMN		**
Family Campephagidae				
1065	Pied Flycatcher-Shrike	INS	**	**
1068	Large Woodshrike	INS	**	
1078	Blackheaded Cuckoo-Shrike	INS		**
1081	Scarlet Minivet	INS	**	**
Family Irenidae				
1103	Goldenfronted Chloropsis	OMN		**
1109	Fairy Bluebird	OMN	**	
Family Pycnonotidae				
1120	Red whiskered Bulbul	OMN	**	**
1128	Red vented Bulbul	OMN		**
1144	Yellowbrowed Bulbul	FRU	**	**
Family Muscicapidae				
1224	Blackheaded Babbler	INS	**	
1259	Rufous Babbler	INS	**	**
1265	Jungle Babbler	INS		**
1173	Slatyheaded Scimitar Babbler	OMN		**
1442	Tickell's Blue Flycatcher	INS	**	**
1446	Nilgiri Flycatcher	INS		**
1449	Greyheaded Flycatcher	INS	**	
1465	Blacknaped Flycatcher	INS	**	**
1538	Tailorbird	INS	**	**
1661	Magpie-Robin	INS	**	**
1728	Malabar Whistling Thrush	INS	**	**
1734	Orangeheaded Ground Thrush	INS		**
Family Paridae				
1794	Grey Tit	OMN	**	**
1809	Yellow-cheeked Tit	OMN	**	
Family Sittidae				
1838	Velvet-fronted Nuthatch	INS	**	**
Family Dicaeidae				
1892	Thickbilled Flowerpecker	FRU		**
1902	Plaincoloured Flowerpecker	FRU	**	**

Table 2 (contd.)

CHECKLIST OF THE BIRD SPECIES OF THADIANKUDISAI AREA, PALNI HILLS, WESTERN GHATS

Family & Synopsis No.	Name of species	Feeding Guild	Presence in:	
			Forest	Plantation
Family Nectariniidae				
1908	Purplerumped Sunbird	NEC	**	**
1909	Small Sunbird	NEC		**
1931	Little Spiderhunter	NEC	**	**
Family Zosteropidae				
1933	White-eye	OMN	**	**
Family Ploceidae				
1968	Whitebacked Munia	GRA		**
Key to feeding guilds:				
FRU: Predominantly frugivorous	BOP: Bird of Prey			
NEC: Predominantly nectarivorous	AQU: Aquatic feeder			
GRA: Predominantly granivorous	OMN: Omnivorous			
INS: Predominantly insectivorous	FSE: Fruit and seed eating			
	FNE: Fruit and nectar eating			

(Ali & Ripley, 1983). This inference is supported by the fact that several of these species were not seen in Pethuparai valley which lacks a good forest cover, i.e. 8 out of 33, including the little spiderhunter, pied flycatcher-shrike and the greater racquet-tailed drongo. Though the magpie-robin was seen in the forest habitat also, it was notably more abundant in plantation plots.

From the presence-absence data in Table 2, one finds that 8 species were found foraging only in forest plots. These included species habitually confined to thick moist deciduous, semi-evergreen or evergreen forest stands, such as the Malabar trogon, the Malabar grey hornbill, the ashy drongo, the yellow-cheeked tit, the large woodshrike and the fairy bluebird. The blackheaded babbler was conspicuous by its absence from plantations, maybe due to lack of leaf litter and dense herbage, which it needs for its foraging. Out of the 14 bird species seen only inside the forest in Thadiankudisai, 11 were not seen in the Pethuparai valley. Further observations are needed to find out if these species have completely disappeared from that area due to the almost complete loss of forest cover. These observations highlight the importance of the remaining patches of forest habitat as a refuge for

these forest avifauna as a colonising source and a primary habitat.

Feeding Guilds

To investigate the impact of coffee-planting on guild abundances, I classified the bird species into feeding guilds based on their major food items (Ali & Ripley, 1983) and my observations on their feeding 'space'. The number of sightings of each species was assumed to be indicative of its relative abundance in the habitat. The relative abundances of each feeding guild are illustrated in Fig. 2. For the feeding guild assigned to each species and description of each guild, refer to Tables 2 and 3.

A series of two-tailed Wilcoxon rank sum tests was done between relative abundances of each feeding guild in the two habitats. It was found that the omnivorous guild of birds was more abundant in plantation habitat as compared to forest habitat ($U=6$, $p<0.0238$). This guild included birds such as the redvented bulbul, the Indian treepie, jungle crow and the goldenfronted chloropsis. This result indicates that the conversion of forest habitat into plantation may cause an increase in the competitive ability of these bird species which are opportunistic

Fig. 2: Relative abundances of feeding guilds in the study plots

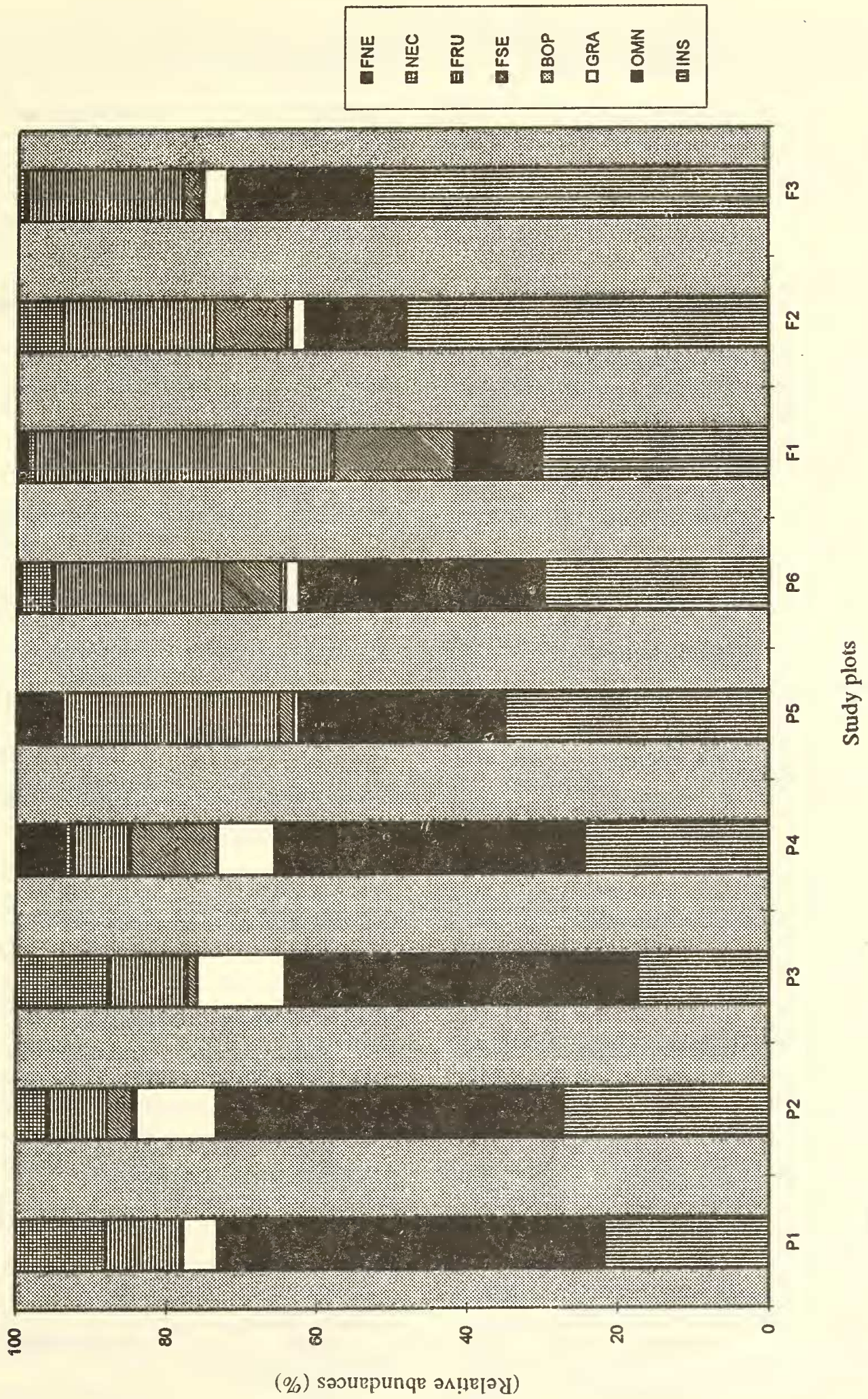


TABLE 3
CHECKLIST OF THE BIRD SPECIES OF PETHUPARAI VALLEY, PALNI HILLS, WESTERN GHATS

Family & Synopsis No.	Common name of species	Feeding Guild	Family & Synopsis No.	Common name of species	Feeding Guild
Family Accipitridae			Family Dicruridae		
124	Blackwinged Kite	BOP	967	Whitebellied Drongo	INS
139	Shikra	BOP	971	Bronzed Drongo	INS
Family Phasianidae			Family Artamidae		
301	Grey Junglefowl	GRA	982	Ashy Swallow-Shrike	INS
Family Rallidae			Family Sturnidae		
343	Whitebreasted Waterhen	AQU	1009	Jungle Mynah	OMN
Family Charadriidae			1015	Grackle Mynah	FRU
366	Redwattled Lapwing	AQU	Family Corvidae		
Family Columbidae			1032	Indian Treepie	OMN
537	Spotted Dove	GRA	1054	Jungle Crow	OMN
542	Emerald Dove	GRA	Family Campephagidae		
Family Psittacidae			1072	Large Cuckoo-Shrike	INS
558	Blossomheaded Parakeet	FSE	1081	Scarlet Minivet	INS
564	Bluewinged Parakeet	FSE	1093	Small Minivet	INS
566	Indian Lorikeet	FNE	Family Irenidae		
Family Cuculidae			1098	Common Iora	INS
573	Common Hawk-Cuckoo	INS	1103	Goldenfronted Chloropsis	OMN
590	Koel	INS	1109	Fairy Bluebird	OMN
600	Crow Pheasant	INS	Family Pycnonotidae		
Family Alcedinidae			1120	Red-Whiskered Bulbul	OMN
722	Common Kingfisher	INS	1128	Redvented Bulbul	OMN
735	White-Breasted Kingfisher	INS	1144	Yellowbrowed Bulbul	FRU
Family Meropidae			Family Muscicapidae		
750	Green Bee-eater	INS	1154	Spotted Babbler	INS
753	Bluebearded Bee-eater	INS	1259	Rufous Babbler	INS
Family Upupidae			1265	Jungle Babbler	INS
763	Hoopoe	INS	1442	Tickell's Blue Flycatcher	INS
Family Capitonidae			1449	Greyheaded Flycatcher	INS
785	Small Green Barbet	FRU	1451	Whitebrowed Fantail Flycatcher	INS
792	Crimson-Breasted Barbet	FRU	1465	Blacknaped Flycatcher	INS
Family Picidae			1511	Plain Wren-Warbler	INS
804	Rufous Woodpecker	INS	1574	Brown Leaf Warbler	INS
819	Lesser Goldenbacked Woodpecker	INS	1661	Magpie-Robin	INS
847	Yellow-fronted Pied Woodpecker	INS	1728	Malabar Whistling Thrush	INS
Family Pittidae			1734	Orangeheaded Ground Thrush	INS
867	Indian Pitta	INS	Family Paridae		
Family Laniidae			1794	Grey Tit	OMN
946	Rufousbacked Shrike	INS	Family Sittidae		
Family Oriolidae			1838	Velvet-fronted Nuthatch	INS
958	Blackheaded Oriole	FRU	Family Dicaeidae		
			1899	Tickell's Flowerpecker	FRU

TABLE 3 (contd.)

CHECKLIST OF THE BIRD SPECIES OF PETHUPARAI VALLEY, PALNI HILLS, WESTERN GHATS

Family & Synopsis No.	Common name of species	Feeding Guild
Family Nectariniidae		
1908	Purplerumped Sunbird	NEC
1917	Purple Sunbird	NEC
Family Zosteropidae		
1933	White-eye	OMN
Family Ploceidae		
1957	Indian Baya	GRA
1968	Whitebacked Munia	GRA
1974	Spotted Munia	GRA
1978	Blackheaded Munia	GRA

Key to feeding guilds:

INS: Predominantly insectivorous

FRU: Predominantly frugivorous

NEC: Predominantly nectarivorous

GRA: Predominantly granivorous

FSE: Fruit and seed eating

OMN: Omnivorous

BOP: Bird of prey

AQU: Aquatic or amphibious feeder

FNE: Fruit and nectar eating

Note: List contains some bird species not seen during my study which had been previously sighted in the area by Mr. Arthur Steele of Bhagyadan Plantation.

and adaptable compared to the forest-loving ones.

Another finding was that the insectivorous guild of birds was more abundant in the forest plots than the plantation plots ($U=23$, $p<0.047$). There could be three possible reasons for this difference: use of pesticides in coffee plantations, reduced depth of leaf litter in plantations and vegetational diversity of forest habitat. It would be interesting to find out if this trend is borne out by more detailed studies, including observations in other seasons.

None of the other feeding guilds showed significant differences in abundance between forest and plantation habitat. (Refer to Table 5 for the p-values of the Wilcoxon rank sum statistic)

TABLE 4

INDICES OF SIMILARITY BETWEEN PAIRS OF PLOTS IN THADIANKUDISAI AREA

Plots	P4	P5	P6	F1	F2	F3
P4		0.43	0.39	0.36	0.38	0.4
P5		1	0.39	0.36	0.32	0.4
P6			1	0.27	0.37	0.31
F1				1	0.37	0.65
F2					1	0.39
F3						1

TABLE 5

COMPARISON OF FEEDING GUILD ABUNDANCES BETWEEN FOREST AND PLANTATION HABITATS OF THADIANKUDISAI (WILCOXON RANK-SUM STATISTICS)

Feeding Guild	Statistic	P-value
INS	23	0.04676**
OMN	39	0.0238**
GFI	28	0.71
GRA	35	0.2619
FSE	25	0.2619
FRU	25	0.2619
NEC	12	0.5476
FNE	0.416	0.6774

Key:

INS: insectivores

OMN: omnivores

GFI: groundfeeding insectivores

GRA: granivores

FSE: fruit and seed-eaters

FRU: frugivores

NEC: nectarivores

FNE: fruit and nectar-eaters

Plantations as Foraging Areas

The pods of the silk-cotton (*Bombax ceiba*) shade trees in coffee plantations were observed to be an abundant source of food for the fruit and seed-eating bird species, including the Indian lorikeet, roseringed parakeet, bluewinged parakeet and blossomheaded parakeet. In one plantation a lesser goldenbacked woodpecker was seen feeding from a jackfruit still on the tree. Flowers of silver oak and orange trees were seen to provide food for several species of parakeets and sunbirds. Thus coffee

plantations were found to be bountiful foraging grounds for a large variety of non-insectivorous birds.

However, the impact of the synchronous flowering pattern found in the plantations (due to monoculturing) as against the random and non-synchronous flowering of the moist deciduous forest ecosystem (which provides forage throughout the year) cannot be commented on unless avian foraging is studied intensively for a whole year.

Plantations as Breeding Areas

According to field observations, coffee plantations may not be as good breeding grounds/nurseries for forest species. Almost all the observations of breeding behaviour were made in forest plots. Fledglings of the bronzed drongo, grey junglefowl, little spiderhunter and the yellowcheeked tit were seen along with adult birds in plots F5 and F6. Courting Malabar grey hornbills were observed in plot F6, while an adult crested serpent-eagle was seen making a nest in plot F5. However, no definite conclusions can be drawn regarding this aspect until a much more detailed study is carried out.

CONCLUSIONS

This preliminary study indicates that in Thadiankudisai, species richness was not affected by conversion of forest habitat into coffee plantations. However, species composition differed significantly between forest and plantation habitats as indicated by the indices of similarity. This difference was due to the several bird species which were observed only in the forest plots. These included species which are reportedly confined to primary forest habitat in the Western Ghats (Ali & Ripley, 1983). Comparison between species composition of Pethuparai and Thadiankudisai indicate that some species may have been lost from the former area due to total loss of forest cover.

However, coffee plantations were found to be important foraging grounds for avifauna in the

middle Palni, capable of supporting the foraging of a large subset (75%) of forest-dwelling species. Field observations indicated that the plantations had a diverse range of bird species utilising available fruit, seed and nectar resources. The relative abundance of the omnivorous guild of birds was significantly higher in plantation plots than in forest plots, while that of the insectivorous guild was higher in forest plots as compared to plantation plots, in the season of study. However, all these results should be treated with caution due to the very limited time-frame of the study. In particular, the assumption that the number of sightings of foraging birds of a species reflect its relative abundance in that particular habitat, may not be justified.

The study, however, does indicate that coffee plantations can be an important buffer between natural forest habitat patches in the mid-Palnis, with high potential for serving as a marginal habitat for some species, a dispersal corridor between patches and even a breeding/permanent habitat for some species. The more 'natural' these plantations can be kept, the richer they would be in terms of structure and the better these conservation functions could be served. Very much more detailed studies need to be carried out to determine exactly which agricultural practices need to be modified to maximise the conservation potential of coffee plantations in the middle Palnis of the Western Ghats.

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REFERENCES

ALI, S. AND S.D. RIPLEY (1983): Handbook of the Birds of India and Pakistan. Oxford University Press. New Delhi.

MEFFE, G.K. AND C.R. CARROLL (1994): Principles of Conservation Biology. Sinauer Associates Inc. Sunderland, Massachusetts.

SUSTAINABLE DEVELOPMENT PROGRAM (1992): Planning for

Interventions in the Palnis. Palni Hills Conservation Council, Kodaikanal and Development Alternatives, Delhi.

WILCOVE, D.S., C.H. McLELLAN AND A.P. DOBSON (1986): Habitat Fragmentation in the Temperate Zone. In Conservation Biology: The Science of Scarcity and Diversity. Ed Michael E. Soule.